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Oblique Bipolar Flaking and the Mode-1 to Mode-2 transition

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1. Introduction

Flint handaxes were made by freehand flaking. The first removals made the flint-nodules resemble choppers; popular conception therefore portrays choppers as forerunners of handaxes (Bordes, 1968). Flaking the complete edge turned these preforms into thick handaxes. Finally, the thickness was reduced by soft hammer flaking. Because this *chaîne opératoire* is completely freehand, many scholars believe that bipolar flaking played a negligible role in the Palaeolithic.

The research in Lomekwi-3 (Harmand *et al.*, 2015) however proves Mode-1 actually began with bipolar flaking. Later sites like Dmanisi (van der Drift, 2012) and Bizat Ruhama (Zaidner, 2013; 2014) show Mode-1 continued to use bipolar methods. Experiments in Africa on local raw materials (Schick & Toth, 1993: 130, 238-239) and the African archaeological record (Sharon, 2006) prove the first handaxes were made from giant (measuring ±25 cm) Oblique Bipolar Flakes (OBFs; van der Drift, 2012). Sharon (2006) named this industry LFB-Acheulian (LFB = Large-Flake-Based) and Sharon *et al* (2009) called making these large OBFs giant-core-technology (**Fig. 1**).

Strikes straight-above and straight-towards the support (anvil or ground) produce bipolar flakes or fragments that run from hammer to support. These Straight Bipolar-on-anvil Flakes (SBFs) often show a crush-mark opposite to the hammer-impact. OBFs form when the strikes are not-straight-above and not-straight-towards the support. This produces a fracture that runs at an angle to the direction of the strike (hence the term oblique) and the distal end of the fracture does not reach the support. By consequence OBFs resemble freehand flakes; most OBFs show a platform, a bulb and a sharp distal edge. OBFs are therefore generally mistaken for freehand flakes.

The diagnostic signals of conchoidal flaking were drawn up to separate freehand flakes from natural bipolar flakes. But OBFs and SBFs are also bipolar, this means a strict interpretation of the diagnostic signals can also reject OBFs and SBFs. Roebroeks and van Kolfschoten (1995)

Fig. 1 – Giant-core-technology. The replica from Konso Gardula KGA 4-A2 illustrates the size of the earliest LFB-handaxes. This size indicates that the blank and core must both have been gigantic. Cores this size cannot be held in the free-and-unsupported hand, so they are flaked bipolar-on-the-ground.
The blanks for the earliest handaxes must therefor be classified as Oblique Bipolar Flakes (OBFs). Photo: J. W. van der Drift.

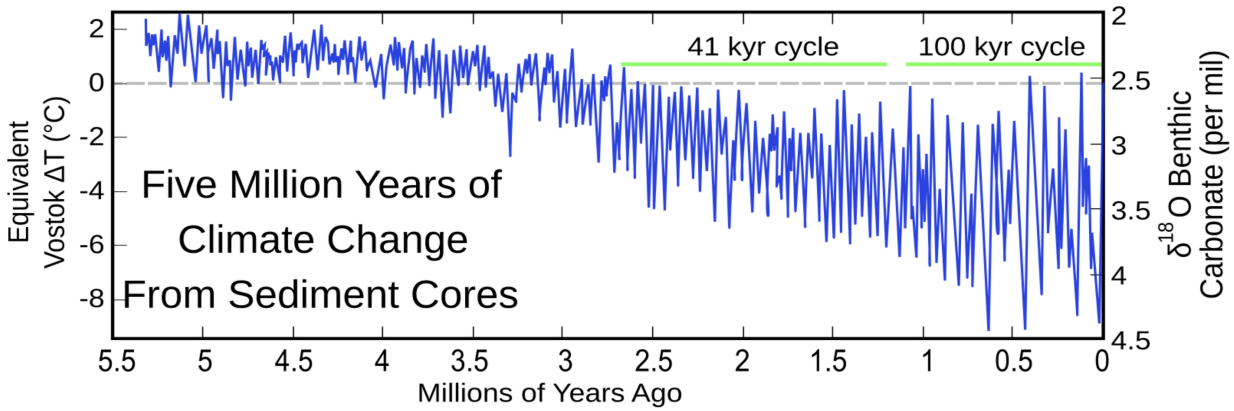

Fig. 2 – Mode-1 began in the cool phase 3.4-3.2 Ma and the number of sites increased at the start of the Pleistocene 2.6 Ma. Mode-2 began at the start of the cool Eburonian 1.76 Ma. Mode-2 spread to the Iberian Peninsula when the 100 kyr cycle began and spread across Southwest-Europe at the start of the Middle-Pleistocene.
Climate-curve from Lisiecki & Raymo (2005). Wikipedia-file: Five_Myr_Climate_Change.svg

therefore classify all OBFs and SBFs as pseudo-artefacts, except for those coming from controlled digs in undisturbed fine-grained context with hominid fossils. We increase the number of windows into our past if we also accept lithics from large typologically correct concentrations (van der Drift, 2010).

2. Mode-1

2.1. The beginning of Mode-1

The earliest known cut-marks date to 3.4 Ma (Dikika; McPherron *et al.*, 2010) and flakes to 3.3 Ma (Lomekwi-3; Harmand *et al.*, 2015). In this timeframe the global temperature dropped almost 4 °C (**Fig. 2**). Colder oceans evaporate less and colder air can hold 7 % less moisture per degree Celsius. This leads to drought and reduces river-forests, so 3.4 Ma there were less fruits and seeds. Hominins instead began to eat bone-marrow, by cracking bones just like apes crack nuts. Some fail-strikes broke stones that lay next to bones. When apes crack nuts the splinters from broken stones are a nuisance; wild apes do therefore not intentionally break stones. But the splinters that touched carcasses cut meat from the bones, so bone-marrow eaters were rewarded for breaking stones. Thus action-and-reward learning taught hominins to cut and to flake.

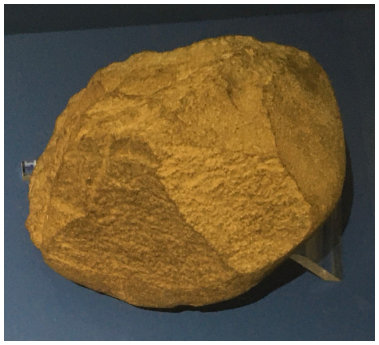

Fig. 3 – Multifacial core 20 cm wide, 4.7 kg, Lomekwi-3. Exhibition "Homo Faber, 2 millions d'années d'histoire de la pierre taillée", 25 June to 9 November 2021, Musée national de Préhistoire - Les Eyzies.

The Lomekwi lithics show bipolar signals like crushed platforms (**Fig. 3**) flat bulbs and central scars (**Fig. 4**). These signals prove the flakes at Lomekwi are OBFs (van der Drift, 2012). The large size indicates the cores and OBFs were made bipolar-on-the-ground; the cores weigh up to 15 kg and the basalt OBF shown at the right in figure 4 measures 13.1 cm (the replica bottom-right in Figure 1 shows the dorsal side of this OBF). It is impossible to lift huge cores in one free-and-unsupported hand, and very difficult to stabilize huge cores on-an-anvil. Lomekwi therefore clearly supports the hypothesis that intentional flaking began bipolar-on-the-ground.

At the start of the Pleistocene 2.6 Ma, the climate became even cooler and dryer. Most vegetable food was found in the river-forests, so the reduction of the river-forests greatly increased the need to scavenge. This significantly increased the number of Mode-1 sites after 2.6 Ma.

2.2. Flaking directions, sizes and modelling

Mode-1 is defined by the absence of bifacial modelling. Texier (2021) blames this absence on poor directional control, but I disagree because already in Lomekwi-3 Mode-1 controlled flaking in all directions. Experiments show bipolar-tool makers set directions by turning the core on-the-ground (or on-the-anvil) into an opportune position. But this doesn't work with flat blanks, because when a flat blank (like the OBF in **Fig. 4**) lies on-the-ground (or on-an-anvil) the hammer-strikes crumble and destroy thin cutting-edges. This explains why Mode-1 did not resharpen OBFs; blunted OBFs were simply discarded and replaced by new OBFs. This inability to flake the cutting-edges of flat blanks led to the absence of bifacial modelling in Mode-1 (also see paragraph 5).

Fig. 4 – Core and OBFs larger than 10 cm, Lomekwi-3. Exhibition "Homo Faber, 2 millions d'années d'histoire de la pierre taillée", 25 June to 9 November 2021, Musée national de Préhistoire - Les Eyzies.

Bipolar techniques can handle any size. Very large boulders were flaked on-the-ground and small stones were flaked on-anvils (the hammer otherwise drives small stones into the ground). Zaidner (2013; 2014) shows small SBFs from Bizat Ruhama and explains how these were made.

Mode-1 sometimes used *contrecoup* techniques (**Fig. 5**) to model fine-grained OBFs and SBFs. Figure 5 reveals that *contrecoup* removals are always at the upper-side, so the modelling-effect was visible without turning the blank over. The toolmaker therefore had no reason to turn the blank over; this explains why Mode-1 retouch is mostly unifacial. In figure 5A-B the edge of the blank is placed exactly on the anvil-contact; this produces smooth retouch. But if the edge is placed over the anvil-contact as in figure 5C a notch forms. *Contrecoup* retouch is therefore often notched or denticulate. *Contrecoup* enables toolmakers to make deep notches in thick blanks.

3. The transition to Mode-2

On the open savanna stones are often hard to find, so Mode-1 carried cobbles from nearby riverbeds to the butchering sites. But in the Tiglian warm-stage (2.4-1.8 Ma) Mode-1 at Kanjera already carried stones over >10 km (Braun *et al*., 2008). This was exhausting and in the Eburonian cool-stage (1.8-1.45 Ma) the drought made groups walk even further in search of food. To save weight, ±1.76 Ma hominids began to carry OBFs instead of complete cobbles. The largest OBFs had the longest cutting-edges. But even giant OBFs became blunt, and Mode-1 was unable to resharpen OBFs on-the-ground (paragraph 2.2). Necessity is the mother of invention, so some toolmakers tried to flake blunt OBFs from the free-and-unsupported hand. This turned out to be a success: it resharpened the OBFs and also produced secondary flakes with sharp edges.

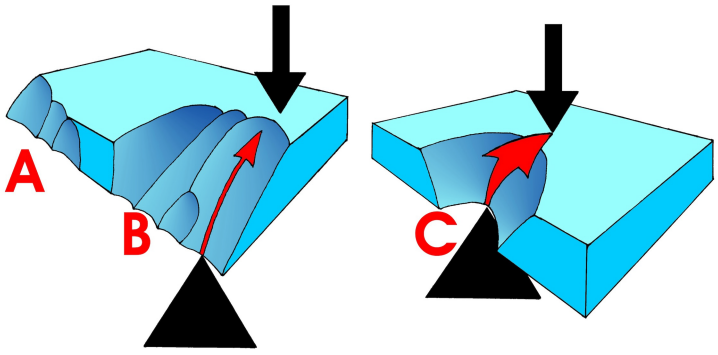

Fig. 5 – Retouching-on-anvil is called *contrecoup* because the rupture starts in the anvil-contact and runs against the direction of the strike. A: steep *contrecoup*, B: flat *contrecoup*, C: deep notching. Drawing: J. W. van der Drift.

Freehand flaking immediately and completely changed the way OBFs were modelled, because the negatives of freehand-flakes always form at the bottom-side. So whilst *contrecoup* gave Mode-1 no reason to turn flat blanks, freehand flaking did exactly the opposite: freehand flaking made it necessary to turn flat blanks after nearly every strike to inspect the results. The repeated turning

inevitably led to bifacial flaking. Removals on OBFs are nearly always centripetal, so the bifacial centripetal freehand flaking immediately turned the giant OBFs into bifaces. The very first bifaces at Konso-Gardula were already recognizable as handaxes, cleavers and pics (Beyene *et al*., 2012). Konso-Gardula furthermore illustrates how the modelling of Mode-2 bifaces was improved and standardized between 1.75 and 0.85 Ma (Beyene *et al*., 2012).

4. Europe

4.1. Back to bipolar

Mode-2 was a success; it spread fast via the Middle-East and 1.5 Ma reached Attirampakkan near Chennai (Pappu *et al*., 2011). But the route from the Middle-East towards Europe brought Mode-2 to the Ponto-Caspian and Danube lowlands. Since lowland-rivers bring only small stones, parents in these lowlands had no raw materials to teach their children the bifacial-modelling-concept. So after just a few generations these migrants lost their Mode-2 concept. They instead used bipolar techniques to flake the small stones into pebble-tools. When these bipolar-tool makers arrived in Europe, they found raw materials for larger OBFs but the mostly forested landscape did not encourage them to carry and resharpen giant OBFs. The Europeans therefore never reinvented the Acheulian. Instead Mode-2 was brought to the Iberian Peninsula ±1 Ma by migrants from Morocco.

4.2. European Acheulian

Lower sea-levels in longer colder ice-ages probably helped Mode-2 cross the Gibraltar-Strait (**Fig. 2**: the 41 kiloyears climate-cycles due to the tilt of the earth-axis shifted ±1 Ma to the 100 kiloyears cycles due to orbit eccentricity). The handaxe from the Cueva Negra is dated to MIS 21 (Walker *et al*., 2014). The Acheulian in South-Europe (*Acheuléen méridional*) often used cobbles. The flattest cobbles were immediately freehand-modelled, but thick cobbles were just like in the LFB-Acheulian first reduced to large OBFs. Small cobbles and small OBFs or SBFs were *contrecoup* modelled into Tayac-points, notched, beaked and denticulated tools. So the *Acheuléen méridional* always combined the freehand with the bipolar techniques.

Since the Caenozoic-cooling continued (Hansen *et al*., 2013) the Lower-Pleistocene forests *ca*. 774 kya (magnetic reversal) made way for the Middle-Pleistocene mammoth-steppe. This steppe was ideal for Mode-2 because it sustained large herds, and the open landscape induced flash floods that brought raw materials for handaxes to the riverbanks. Mode-2 now spread to Northwest-France and England; here the predominant use of flint-nodules made the Acheulian almost exclusively freehand. This northern industry is called Classic Acheulian (*Acheuléen classique*) because this is where Frère and Boucher de Perthes first understood handaxes were man-made. The downside of being exclusively freehand is that the Classic Acheulian could not make flake-based-cleavers because these require large OBF-blanks. Tayac-points, deep notches, beaked and denticulated tools are also rare in the Classic Acheulian because these require *contrecoup*.

4.3. Clactonian OBFs

In the coldest part of MIS 12 even reindeer sought refuge in the south of France, so the hunter-gatherers abandoned the French-English flint-area and withdrew to southern refugia like Tautavel. Plants and animals returned north when temperatures rose again at the start of MIS 11, and the Acheulian hunter-gatherers followed. Pioneers always take the easiest routes, so all groups to the west of the Massif-Central followed the Garonne-valley downstream. This valley led the pioneers to the lowlands at Bordeaux and the Atlantic coast. Crossing these lowlands took several generations and parents in lowlands cannot teach their children Mode-2 modelling (paragraph 4.1). So the next generations used bipolar techniques. Their descendants migrated to Northwest-Europe, where they made Middle-Pleistocene bipolar industries with OBFs and pebble-tools.

Fig. 6 – Turning the core after each bipolar-on-the-ground strike and using the previous negative as platform (SSDA) produces OBFs that match Clactonian-flakes. Photo: J. W. van der Drift.

The most famous of these bipolar industries is the Clactonian. **Figure 6** shows that experimental bipolar-on-the-ground flaking produces the Clactonian characteristics. Turning the cores after each removal and using the previous negative as platform for the next strike (*Système par Surface de Débitage Alterné*, SSDA: Forestier, 1993) leads to zig-zag cores which produce OBFs with non-faceted platforms. Using the ground as a support enhances the force, by consequence strikes are placed further from the edge resulting in typical large (wide and deep) platforms. The OBFs show diffuse bulbs (varying from flat to huge bulges), whilst Acheulian freehand-flakes show smaller contrasting bulbs. The average platform-to-ventral-face angle of Acheulian freehand-flakes was 110-120°, but OBFs are pulled towards the support and this changed the angle of the Clactonian flakes to 120-130°. *Contrecoup* modelled OBFs into characteristic flaked-flakes and bill-hooks.

Whilst the pioneers in England were making Clactonian, the Acheulian population in the Middle-Garonne slowly grew. After several centuries this growth pushed the next generations into the foothills of the Massif-Central. There are plenty raw materials for handaxes in these foothills, so the parents taught their children how to make handaxes. This second migration-wave brought Mode-2 back north; Ashton *et al.* (2016) show Mode- 2 reached England ±10.000 years after the Clactonian. Other examples of Northwest-European Middle-Pleistocene bipolar industries were published by Peeters *et al.* (1988), but disputed by Roebroeks and van Kolfschoten (1995) because the lithics did not come from controlled digs in undisturbed fine-grained context with hominid fossils.

5. Discussion and conclusions

The fact that some Mode-1 OBFs show indisputable bipolar flaking-signals (van der Drift, 2012) proves Mode-1 used bipolar flaking. But in the 20th century the theory was taken for granted that Mode-1 must be freehand because it was the forerunner of Mode-2. It is difficult to overcome that assumption because most OBFs resemble freehand flakes. So how can we investigate if Mode-1 was predominantly freehand or predominantly bipolar?

The first indications that Mode-1 was predominantly bipolar are the flaking directions, sizes and modelling (paragraph 2.2). But the fact that Mode-1 continued to make large OBFs from 3.3 Ma to 1.8 Ma provides the decisive answer, because we can test what happens when large OBFs get flaked with the freehand method.

To test this, I gave a dozen test-subjects (varying from skilled experimentalists to people who had never flaked a stone) each two large OBFs, and asked them to freehand-flake those 24 OBFs at will. One skilled experimentalist used bifacial edge-modelling to extract a ridged-blade (*lame à crête*) followed by more blades, all other OBFs were freehand-modelled into bifaces (of varying quality). Since freehand flaking of large OBFs in all test-cases resulted in bifacial modelling, it is impossible that Mode-1 freehand-flaked large OBFs for one-and-a-half million years without bifacial modelling. The absence of bifacial modelling in Mode-1 therefore provides conclusive evidence for my claim that Mode-1 predominantly used bipolar flaking.

We can safely presume the hominins at Lomekwi-3 had not yet evolved the skill and intelligence needed to make handaxes. But the groups from the Middle-East that migrated to Europe between 1.5 and 1 Ma had the same cognitive capabilities as their Acheulian contemporaries. And the groups who made the Clactonian other Middle-Pleistocene non-Acheulian industries had the same cognitive capabilities as the Middle-Pleistocene Acheulian groups. Yet they all failed to reinvent Mode-2. This indicates the bifacial-modelling that typifies Mode-2 only developed under the special circumstances explained in paragraph 3: the need to carry and freehand-resharpen large OBFs. The contemporaneity furthermore proves that Mode-2 is not simply a cognitive-evolutionary stage, but the result of the transfer (by teaching and migrations) of specific technical knowledge.

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Abstract

The archaeological record shows that the earliest known flakes were made on the ground. Mode- 1 made Oblique Bipolar Flakes on-the-ground and on-anvil. Freehand flaking giant Oblique Bipolar Flakes led to Mode-2. For a better understanding of the Mode-1 to Mode-2 transition, this paper also discusses the Lower-Pleistocene and Middle-Pleistocene non-Acheulian traditions.

Keywords: Early Paleolithic, Debitage, Oblique Bipolar Flakes, Mode-1, Mode-2.

Samenvatting

Archeologische vondsten tonen aan dat de oudste afslagen op de grond werden gemaakt. Mode- 1 maakte Schuine Bipolaire Afslagen op-de-grond en op-aambeeld. Het maken van afslagen uit de vrije hand van reusachtige Schuine Bipolaire Afslagen leidde tot Mode-2. Voor een beter begrip van de Mode-1 - Mode-2 transitie, bespreekt dit artikel ook Vroeg-Pleistocene en Midden-Pleistocene niet-*Acheuléen* tradities.

Trefwoorden: Vroeg Paleolithicum, debitage, Schuine Bipolaire Afslagen, Mode-1, Mode-2.

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